



United States Environmental Protection Agency  
Office of Enforcement and Compliance Assurance  
Office of Criminal Enforcement, Forensics and Training

National Enforcement Investigations Center

NEIC

**NEICRP1899X03**

**Toxicity of Hydrogen Sulfide Associated with Aghorn Operations**

**United States of America v. Aghorn Operating Inc., Trent Day, and  
Kodak Roustabout Inc. 7:22-cr-00049-DC**

**Aghorn Energy**

Ector County, Texas  
NEIC Project No.: RP1899  
CID Case No. 0606-M595  
October 18, 2022

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I, Kristen Keteles, am employed as a toxicologist by the U.S. Environmental Protection Agency (EPA), Office of Enforcement and Compliance Assistance, National Enforcement Investigations Center (NEIC). I have a Ph.D. in zoology from Louisiana State University with an emphasis in environmental toxicology. I routinely write expert opinion reports and testify on the potential for harm from chemical releases to human health and environment for both civil and criminal litigations. I have worked for EPA for 14 years, including 7 years as a regional toxicologist/risk assessor, routinely conducting human health risk assessments at Superfund hazardous waste sites. I also regularly provided technical expertise to the EPA Region 8 and National Emergency Response and Removal programs regarding immediate threats posed to public health and the environment from spills and releases. I also served as the chair of EPA's Risk Assessment Forum Human Health Oversight Committee, a committee of senior EPA scientists tasked with overseeing the development of guidance pertaining to human health risk and toxicity assessment. As a U.S. government employee, I am compensated by only my normal salary as a GS-14 for this work. My curriculum vitae is attached to this report as **Appendix A**. It includes a list of publications authored by me and a list of all cases in which I have testified as an expert witness.

### **SUMMARY**

Hydrogen sulfide (H<sub>2</sub>S) is a highly toxic gas that can be deadly. At high concentrations, only a few breaths can lead to rapid depolarization within the central nervous system, immediate loss of consciousness, coma, respiratory paralysis, seizures, and death.<sup>1</sup> Jacob and Natalee Dean died from exposure to H<sub>2</sub>S at the Aghorn Operating, Inc. (Aghorn Operations) Foster D Waterflood Station (the Facility) on October 26, 2019. Lack of adequate warning systems and personal protective equipment contributed to their deaths. It is also evident that the chronic H<sub>2</sub>S emissions associated with Aghorn Operations combined with the lack of adequate warning systems and personal protective equipment, put the health and safety of workers, first responder, and the public in jeopardy.

### **FACTORS CONTRIBUTING TO THE DEATHS OF JACOB AND NATALEE DEAN**

Jacob and Natalee Dean succumbed to hydrogen sulfide gas poisoning when they were exposed at the Aghorn Energy Foster D Waterflood Station on October 26, 2019. According to the Ector County medical examiner reports, the cause of death for both Jacob and Natalee Dean was

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<sup>1</sup> ATSDR 2016 Toxicological Profile for Hydrogen Sulfide.

acute hydrogen sulfide inhalation.<sup>2 3</sup> Jacob Dean's blood thiosulfate, an indicator of H<sub>2</sub>S exposure, was 13 micrograms per milligram (µg/mL), and Natalee Dean's thiosulfate blood level was 16 µg/mL (**Table 1**). Thiosulfate is a metabolite of hydrogen sulfide from the conversion of H<sub>2</sub>S to thiosulfate. The normal blood thiosulfate level is 0.3 µg/mL.<sup>4</sup> Therefore, Mr. Dean's blood thiosulfate levels were 43 times the normal level of thiosulfate, and Mrs. Dean's blood thiosulfate levels were 53 times the normal level. Levels ranging from 8 to 77 times the normal level of 0.3 µg/mL have been documented in previous H<sub>2</sub>S exposure-related fatalities.<sup>5</sup> Although urine thiosulfate elevation may be present in nonfatally exposed workers, elevated urine thiosulfate does not occur with rapid fatalities because of the time it takes to distribute metabolites to the bladder for elimination in the urine. Mr. Dean's urine thiosulfate level was 1.9 µg/mL, 2.2 mg/g creatinine<sup>6</sup>; normal urine concentrations are below 9.2 µg/mL, 7.8 milligrams per gram (mg/g) creatinine (Table 1). The fact that Mr. Dean's urine thiosulfate level was below normal levels suggests that Mr. Dean succumbed rapidly to H<sub>2</sub>S exposure. Additionally, the fact that Mr. Dean's blood contained the metabolite of hydrogen sulfide does suggest that death occurred after the hydrogen sulfide was metabolized to thiosulfate.<sup>7</sup> The conversion of H<sub>2</sub>S to thiosulfate occurs extremely rapidly in the blood. Therefore, it is likely that respiration ceased, and death occurred very rapidly.

<b>Table 1. POSITIVE FINDINGS FROM THE TOXICOLOGY REPORTS FOR THE AUTOPSIES OF JACOB AND NATALEE DEAN</b>				
<b>Decedent</b>	<b>Analyte</b>	<b>Matrix</b>	<b>Result</b>	<b>Normal Level</b>
Natalee Dean	Thiosulfate	Blood	16 µg/mL	0.3 µg/mL
Jacob Dean	Thiosulfate	Blood	13 µg/mL	0.3 µg/mL
Jacob Dean	Thiosulfate	Urine	1.9 µg/mL	<9.2 µg/mL
Jacob Dean	Thiosulfate creatinine-corrected	Urine	2.2mg/g	<7.8 mg/g

The medical examiner also documented severe pulmonary congestion with edema, along with visceral congestion and bronchial mucus in the decedents.<sup>8 9</sup>Edema occurs when fluids fill up in the lungs, making breathing difficult. Autopsy findings from fatal H<sub>2</sub>S exposures commonly

<sup>2</sup> AGH OPER 0004109 Ector County Medical Examiner Autopsy and Toxicology Reports for Jacob Daniel Dean.

<sup>3</sup> AGH OPER 0006194 Ector County Medical Examiner Autopsy and Toxicology Reports for Natalie Marie Dean.

<sup>4</sup> Diane Ballerino-Regan, Atkinson W. Longmire. 2010. Hydrogen sulfide Exposure as a Cause of Sudden Occupational Death *Arch Pathol Lab Med* (2010) 134 (8): 1105.

<sup>5</sup> Diane Ballerino-Regan, Atkinson W. Longmire. 2010. Hydrogen sulfide Exposure as a Cause of Sudden Occupational Death *Arch Pathol Lab Med* (2010) 134 (8): 1105.

<sup>6</sup> AGH OPER 0004109 Ector County Medical Examiner Autopsy and Toxicology Reports for Jacob Daniel Dean.

<sup>7</sup> Sayer, S.S., D.L. Cannon, K. Fagan, and C.P. Weis. 2017. Occupational hydrogen sulfide fatalities and thiosulfate levels. *Am J Forensic Med Pathol*. 38 (1): 47-48.

<sup>8</sup> AGH OPER 0004109 Ector County Medical Examiner Autopsy and Toxicology Reports for Jacob Daniel Dean.

<sup>9</sup> AGH OPER 0006194 Ector County Medical Examiner Autopsy and Toxicology Reports for Natalie Marie Dean.

include hemorrhagic pulmonary edema, visceral congestion, and bronchial secretions.<sup>10</sup> Hydrogen sulfide is an extremely rapidly acting, highly toxic gas and is rapidly absorbed by the lungs.<sup>11</sup> At 300 parts per million (ppm) or higher, rapid onset of pulmonary edema, agitated behavior, cyanosis (bluish skin and mucus membranes), and hemoptysis (blood-tinged sputum) can occur.<sup>12</sup> At exposure levels of 500 ppm to 1000 ppm, H<sub>2</sub>S is neurotoxic, abruptly causing sudden dizziness, unconsciousness, respiratory paralysis, and/or death. Exposure to higher levels (>1000 ppm) causes an immediate loss of consciousness, cessation of breathing, and death if the exposed individual is not expeditiously removed. Death was likely rapid for Mr. Dean, as evidenced by elevated blood thiosulfate and low urine thiosulfate levels.<sup>13</sup> Furthermore, Natalee Dean was on the phone with Jacob Dean's parents when she entered the building and immediately lost consciousness.<sup>14 15</sup> Therefore, based on the sudden loss of consciousness and rapid death, H<sub>2</sub>S levels were likely well over 500 ppm. The monitoring results from Odessa Fire Department Engine 4 during the response also show levels of 343 ppm when responders first entered the building and levels of 480 ppm where the bodies of Jacob and Natalee Dean were found (**Figure 1**).<sup>16 17 18</sup> These levels also would have posed a lethal hazard to responders had they not had proper personal protective equipment. Levels measured during the response are extremely dangerous and can cause loss of consciousness and death.

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<sup>10</sup> Diane Ballerino-Regan, Atkinson W. Longmire. 2010. Hydrogen sulfide Exposure as a Cause of Sudden Occupational Death *Arch Pathol Lab Med* (2010) 134 (8): 1105.

<sup>11</sup> ATSDR 2016 Toxicological Profile for Hydrogen sulfide,

<sup>12</sup> Diane Ballerino-Regan, Atkinson W. Longmire. 2010. Hydrogen sulfide Exposure as a Cause of Sudden Occupational Death *Arch Pathol Lab Med* (2010) 134 (8): 1105.

<sup>13</sup> AGH OPER 0004109 Ector County Medical Examiner Autopsy and Toxicology Reports for Jacob Daniel Dean.

<sup>14</sup> AGH OPER 0003686 IAR of 1st Interview with [REDACTED] 12/09/19.

<sup>15</sup> AGH OPER 0005007 Inge Jacob Dean Death Investigation Report.

<sup>16</sup> AGH OPER 000611 Engine 4 Spreadsheet.

<sup>17</sup> AGH OPER 000463 IAR of Nolan Weatherford 4/7/20.

<sup>18</sup> AGH OPER 0010819 Mark Brown IAR 5-19-20.



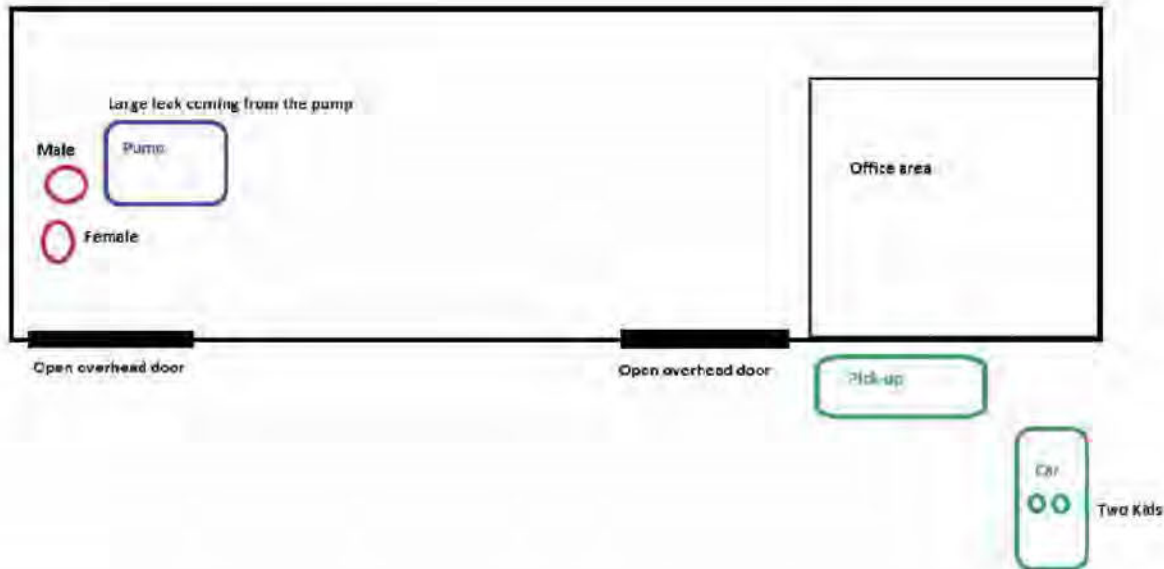


Figure 1. Schematic from Odessa Fire Department Engine 4 showing the scene on October 26, 2019. Levels of H<sub>2</sub>S where Jacob and Natalee Dean were found deceased were 480 ppm when responders arrived. Levels were 343 ppm at the entrance.<sup>19</sup>

Given the high toxicity of H<sub>2</sub>S, it is important to have monitoring and alarm systems in place in areas prone to H<sub>2</sub>S emissions. Hydrogen sulfide has a characteristic “rotten egg,” odor and the threshold at which humans can smell it ranges from 0.008 and 0.13 ppm.<sup>20</sup> Concentrations greater than 100 ppm may overwhelm the sense of smell, a condition called olfactory fatigue, so that the victim may have no warning of exposure. Paralysis of the olfactory nerve can occur at concentrations above 150 ppm. Even continuous exposure to low concentrations of hydrogen sulfide can result in olfactory fatigue and loss of the ability to smell or detect the gas in the environment. Because olfactory fatigue conceals the warning of the imminent danger, it is imperative to have adequate monitoring and alarms in areas where H<sub>2</sub>S may be present.

Tests performed by Diversified Detection Services, Inc. after the incident revealed that none of the stationary monitoring devices inside the facility were operable.<sup>21</sup> Additionally, an expert retained by plaintiffs in a civil case, Eric Benstock, observed that the monitors were “dirty, old and were not properly operating based upon their appearance.”<sup>22</sup> Benstock found that the monitors were in “inhibit mode” (i.e., manually shut off) or were otherwise not functional and

<sup>19</sup> AGH OPER 0006521 Engine 4 Schematic.

<sup>20</sup> National Academy of Sciences. Acute Exposure Guideline Levels for Selected Airborne Chemicals, Volume 9.

<sup>21</sup> AGH OPER 0009193 Diversified Report 3-17-20 Test of the H<sub>2</sub>S Detection System.

<sup>22</sup> AGH OPER 0005527 Eric Benstock 4-13-20 IAR.

inoperable, confirming the finding of Diversified Detection Services, Inc. Furthermore, Mr. Benstock stated that the only reason to manually shut off the stationary alarms would be for calibration purposes.<sup>23</sup> Therefore, the alarms should not have been turned off during normal operations. Arvelia Woods, an Occupational Safety and Health Administration (OSHA) industrial hygienist, also determined that many of the sensors were in inhibit mode and would not alert employees of the presence of H<sub>2</sub>S.<sup>24</sup> Some sensors gave no reading and appeared old and unmaintained. Woods found that only one sensor was semi-operable, but it was in inhibit mode, so there would have been no warning the day that Jacob and Natalee Dean succumbed to H<sub>2</sub>S exposure. The lack of adequate warning systems appears to be a persistent issue at the facility. According to [REDACTED], former Aghorn employee [REDACTED] H<sub>2</sub>S monitors were never tested or calibrated and did not work.<sup>25</sup> Aghorn employee [REDACTED] never heard stationary monitors alert and even questioned whether his personal monitor worked since it was never calibrated.<sup>26</sup> [REDACTED], [REDACTED], and [REDACTED], employees of Knighten Industries, said that Aghorn stationary monitors did not alert even when their personal monitors alarmed due to high levels of H<sub>2</sub>S.<sup>27 28 29</sup> [REDACTED], an Aghorn relief pumper at the Facility from 2015-2016, also indicated that he never heard the stationary H<sub>2</sub>S alarms, even when his personal alarm alerted to levels over 100 ppm.<sup>30</sup> The lack of working H<sub>2</sub>S monitors, combined with the fact that olfactory fatigue or paralysis, would have prevented Jacob and Natalee Dean from recognizing the imminent danger.

Adequate warning is important in order to assess the need for proper personal protective equipment. In fact, levels above 100 ppm are considered “Immediately Dangerous to Life or Health” (IDLH) and require the use of a respirator with an air supply or a “self-contained breathing apparatus” (SCBA). A photo of deceased Jacob Dean reveals facial hair, which would have prevented a secure fit of the respirator, interfering with its proper function, and is indicative of lack of fit-testing by Aghorn (**Figure 2**).<sup>31</sup> Aghorn employees indicated that respirator fit-testing was not done, and many employees even lacked access to a proper respirator. For example, Aghorn employee [REDACTED] said he was not fit-tested prior to

<sup>23</sup> AGH OPER 0005527 Eric Benstock 4-13-20 IAR.

<sup>24</sup> AGH OPER 0010833 Arvelia Woods 6-10-20 IAR.

<sup>25</sup> AGH OPER 0003686 IAR of 1st Interview with [REDACTED] 12/09/19.

<sup>26</sup> AGH OPER 0017913 [REDACTED] 12-8-20 IAR.

<sup>27</sup> AGH OPER 0004302 IAR [REDACTED] of Knighten Industries 4/10/20.

<sup>28</sup> AGH OPER 0016377 [REDACTED] Interview 8-18-20 IAR.

<sup>29</sup> AGH OPER 0016379 [REDACTED] 8-19-20 IAR.

<sup>30</sup> AGH OPER 0017900 [REDACTED] 12-8-20 IAR Interview.

<sup>31</sup> AGH OPER 0005238 Photo of deceased Jacob Dean.

the Dean accident.<sup>32</sup> [REDACTED], Aghorn foreman, did not have a fit test, and [REDACTED], a former Aghorn employee, stated he was never fit-tested while he worked at Aghorn nor did he even receive a respirator.<sup>33</sup> <sup>34</sup> [REDACTED] said he was fit-tested only once in his 20 years with Aghorn, and to his knowledge, other employees had not been fit-tested.<sup>35</sup> [REDACTED], former Aghorn employee, did not receive training and, in addition to not being fit-tested, was not even issued a respirator.<sup>36</sup> Therefore, in addition to a lack of fit-testing, it is also evident that employees lacked access to proper respiratory protection equipment. The OSHA violation worksheet for violation 1-2 states, "The SCBA respirator at the facility was deficient. The respirator was in a black case with a missing mask and with an empty cylinder. The employer had not maintained the respirator to ensure it was used according to NIOSH certification as well as being in compliance with the certification."<sup>37</sup> As a result, OSHA issued a "Citation and Notification of Penalty" on April 23, 2020, finding Aghorn in violation of numerous "serious" respiratory requirements including, "The employer did not provide a respirator fit test for employees who wore respiratory protection," "employees who wore respirators where not provided comprehensive, understandable annual training," and "the employer selected a respirator that was not NIOSH certified and in compliance with this certification."<sup>38</sup>

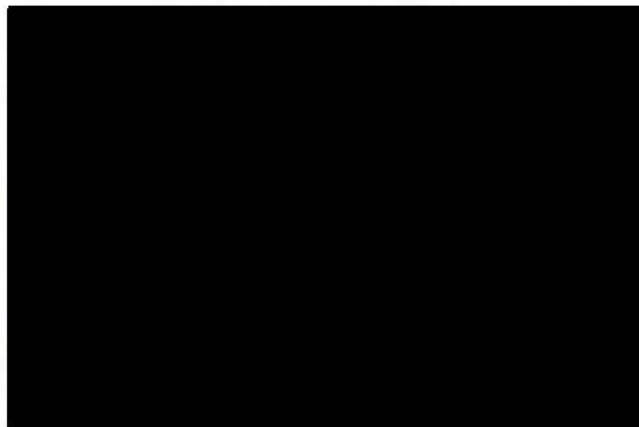


Figure 2. Photo of deceased Jacob Dean showing facial hair.

<sup>32</sup> AGH OPER 0009421 [REDACTED] Statement.

<sup>33</sup> AGH OPER 0004832 Chemical Safety Board Interview with [REDACTED].

<sup>34</sup> AGH OPER 0016454 [REDACTED] Interview 8-18-20 IAR.

<sup>35</sup> AGH OPER 0003686 IAR of 1st Interview with [REDACTED] 12/09/19.

<sup>36</sup> AGH OPER 0017900 [REDACTED] 12-8-20 IAR Interview.

<sup>37</sup> AGH OPER 0009388 Violations Worksheet 1-2.

<sup>38</sup> AGH OPER 0009136 Citation and Notification of Penalty.



## RISKS TO WORKERS

Given the history of elevated H<sub>2</sub>S levels, the lack of warning systems at the Aghorn Operations Foster D Waterflood Station, insufficient personal protective equipment, and the fact that past and present employees have been sickened from H<sub>2</sub>S, workers were at imminent and substantial danger from exposure to H<sub>2</sub>S. Several employees recounted that H<sub>2</sub>S levels were consistently elevated, as indicated by their personal monitors and alarms. [REDACTED], an employee of Knighten Industries, noted that his personal H<sub>2</sub>S monitor alerted “all the time,” with high alarms over 15 ppm when he went into the bay building at the Waterflood Station to perform maintenance on the pumps.<sup>39</sup> [REDACTED] of Knighten Industries also recounted his personal alarm reading over the limit of 100 ppm “nearly every time” and experiencing headaches when on-site.<sup>40</sup>

Produced water is the source of the hydrogen sulfide at the Facility, and entrained hydrogen sulfide off-gasses upon contact with the air.<sup>41</sup> <sup>42</sup> Aghorn employee [REDACTED] noted that there were many leaks, and the pump equipment was corroded from the constant release of H<sub>2</sub>S.<sup>43</sup> From 2007 to 2019, 131 samples of produced water from Aghorn were analyzed by BioTech and show consistently high levels of H<sub>2</sub>S dissolved in the produced water, with a median concentration of 650 milligrams per liter (mg/L) and an average concentration of 657 mg/L.<sup>44</sup> In his expert report, Dr. Joe Lowry, NEIC chemist, estimated initial H<sub>2</sub>S concentrations dissolved in the produced water to be 550 to 641 mg/L, which is consistent with the average and median concentrations reported by BioTech.<sup>45</sup> These high levels of H<sub>2</sub>S dissolved in the produced water are capable of being off-gassed, resulting dangerous levels of H<sub>2</sub>S in air. The Texas Railroad Commission requires that operators measure H<sub>2</sub>S concentrations in the head space or air of a tank to determine the amount of hydrogen sulfide in the produced water that will partition from the water to air. Aghorn reported tank vapor hydrogen sulfide concentrations of 96,000 ppm and 110,000 ppm at the Facility. These levels are extremely high and demonstrate the potential of off-gassing hazardous H<sub>2</sub>S.<sup>46</sup> The bulk samples collected by OSHA following the Dean fatalities were off-gassing hazardous levels of H<sub>2</sub>S, and the MultiRAE

<sup>39</sup> AGH OPER 0016377 [REDACTED] Interview 8-18-20 IAR.

<sup>40</sup> AGH OPER 0004302 IAR [REDACTED] of Knighten Industries 4/10/20.

<sup>41</sup> AGH OPER 0015857 Jim Kirksey Preliminary Report 8-18-20.

<sup>42</sup> NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>43</sup> AGH OPER 0017913 [REDACTED] 12-8-20 IAR.

<sup>44</sup> NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>45</sup> NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>46</sup> AGH OPER 0003179 Texas Railroad Commission Form H-9 1/17/201.2

gas monitor showed 100 ppm of H<sub>2</sub>S off-gassed from the samples during collection.<sup>47</sup> OSHA analyzed the amount of H<sub>2</sub>S off-gassed from bulk water samples and measured levels of 62, 173, and 134 ppm.<sup>48</sup> As Dr. Lowry points out in his expert report, the values obtained by OSHA should be considered minimal due to loss to the atmosphere from containers that were not airtight and because the samples were not preserved to minimize oxidation of the H<sub>2</sub>S.<sup>49</sup> In his report, Dr. Lowry concludes that “the high concentrations of hydrogen sulfide and hydrosulfide ion in the produced water along with the large volume of produced water handled indoors at the facility posed an extremely hazardous situation due to the toxicity of hydrogen sulfide.” Given the consistent presence of high levels of H<sub>2</sub>S in produced water at the Facility and the propensity for leaks and spills, exposure to H<sub>2</sub>S was a constant threat to workers and required proper monitoring and the use of personal protective equipment.

Occupational studies have demonstrated that symptoms observed in workers exposed to daily to concentrations of hydrogen sulfide that often exceeded 20 ppm include fatigue, loss of appetite, headache, irritability, poor memory, and dizziness.<sup>50</sup> Several past and current employees described illnesses consistent with H<sub>2</sub>S exposure. For example, [REDACTED] of Knighten Industries worked at the Foster D Waterflood Station once and described an incident in 2018 in which he vomited and experienced tightness in chest and a headache.<sup>51</sup> Former Aghorn employee [REDACTED] suffered from headaches while working at Aghorn and recalled having a headache that lasted for 3 days after being exposed to H<sub>2</sub>S in the Foster D Waterflood Station pumphouse.<sup>52</sup> At the time of his symptoms, levels of H<sub>2</sub>S were 83-90 ppm, according to a monitor, and these levels could result in the symptoms that he experienced. [REDACTED], a former pumper at the Facility from 1996-2002, described H<sub>2</sub>S levels in excess of 500 ppm and recounted an incident in which he provided aid to a Kodiak roustabout worker, [REDACTED], who lost consciousness.<sup>53</sup> This account was corroborated by [REDACTED] and [REDACTED].<sup>54 55</sup> [REDACTED] also described another incident when an employee [REDACTED], lost consciousness, and

<sup>47</sup> AGH OPER 0012408 Interview 6-18-20 Daniel Johansen IAR.

<sup>48</sup> AGH OPER0017103 Colon-Jusino Interview 06/18/2020.

<sup>49</sup> NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>50</sup> World Health Organisation. 2003. Concise International Chemical Assessment Document 53 HYDROGEN SULFIDE: HUMAN HEALTH ASPECTS.

<sup>51</sup> AGH OPER 0003678 IAR [REDACTED] Knighten Industries 1/28/2020.

<sup>52</sup> AGH-OPER-0017900 [REDACTED] 12-8-20 IAR Interview.

<sup>53</sup> AGH OPER 0005389 [REDACTED] IAR 4/28/20.

<sup>54</sup> AGH OPER 0005397 [REDACTED] IAR 3/20/20.

<sup>55</sup> AGH OPER 0003686 IAR of 1st Interview with [REDACTED] 12/09/19.

a member of [REDACTED] crew also fainted and cracked a tooth from the fall.<sup>56 57</sup> After the fatal incident involving Jacob and Natalee Dean, OSHA inspector Michael Formoso was exposed to H<sub>2</sub>S while collecting samples for the investigation.<sup>58</sup> Mr. Formoso felt dizzy and went to the emergency room. At the time of Mr. Formoso's exposure, the H<sub>2</sub>S monitor showed levels of 357 ppm. Significant injury to the central nervous system (CNS) occurs immediately after high exposures to hydrogen sulfide, such as levels above 300 ppm. Signs and symptoms of the effects on the CNS include excitation, rapid breathing, headache, impaired gait, dizziness, and coma, which can progress to respiratory paralysis and death.<sup>59</sup> Workers were at risk of adverse health effects, including persistent and permanent nerve damage,<sup>60 61</sup> from exposure to the consistently elevated levels of H<sub>2</sub>S at the Facility.

Previous exposure incidents and the levels detected by monitors and analytical instruments indicate dangerous levels of H<sub>2</sub>S consistently existed at the Facility, putting workers at risk of permanent disability and death. Nonfatal exposures can have long-term impacts. Survivors of severe exposure that result in the loss of consciousness may develop psychological disturbances and permanent damage to the brain. Occupationally exposed workers have reported permanent or persistent neurological effects, including headaches, poor concentration ability and attention span, impaired short-term memory, and impaired motor function.<sup>62</sup> Neurologic symptoms that persist 5-10 years after nonfatal exposures include impaired vision, memory loss, decreased motor function, tremors, ataxia, abnormal learning and retention, and slight cerebral atrophy.<sup>63</sup> Heart damage can also result after high levels of exposure to H<sub>2</sub>S, and the cornea may be also become permanently scarred, affecting the vision.

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<sup>56</sup> AGH OPER 0003692 [REDACTED] IAR 12-11-19 Interview from Relativity.

<sup>57</sup> AGH OPER 0003686 IAR of 1st Interview with [REDACTED] 12/09/19.

<sup>58</sup> AGH OPER 0009749 Interview of Michael Formoso 6-10-20.

<sup>59</sup> ATSDR. 2014. Medical Management Guidelines H<sub>2</sub>S.

<sup>60</sup> Snyder, J.W., E.F. Safir, G.P. Summerville, R.A. Middleberg. 1995. Occupational fatality and persistent neurological sequelae after mass exposure to hydrogen sulfide. *The American Journal of Emergency Medicine*. 13 (2) 199-203.

<sup>61</sup> Tvedt, B., K. Skyberg, O. Aaserud, A. Hobbesland, and T. Mathiesen. 1991. Brain Damage Caused by Hydrogen Sulfide: A Follow-Up Study of Six Patients. *American Journal of Industrial Medicine* 20:91-101.

<sup>62</sup> ATSDR. 2016. Toxicological Profile for Hydrogen Sulfide.

<sup>63</sup> National Academy of Sciences. Acute Exposure Guideline Levels for Selected Airborne Chemicals, Volume 9.

## RISKS TO THE PUBLIC

The public could be exposed from hydrogen sulfide releases and produced water leaks at the Facility. When investigating the deaths of Jacob and Natalee Dean on October 26, 2019, the Ector County forensic death investigator, Ron Inge, noticed the H<sub>2</sub>S odor a mile from facility, indicating that H<sub>2</sub>S emissions were traveling off-site.<sup>64</sup> Furthermore, Dr. Lowry calculated that a release of 46.2 pounds per hour from the south bay door of the facility with the wind from the southwest (200 degree) at 6 miles per hour at 10 meters is capable of producing concentrations that could exceed the occupational ACGIH (American Conference of Government Industrial Hygienists) 8 hour time weighted average threshold limit value (TLV) of 1 ppm up to 1233 yards from the facility. Additionally, those conditions could result in concentrations that exceed the 1-hour EPA Acute Exposure Guideline Level 1 (AEG1) of 0.51 ppm up to a mile from the Facility potentially affecting a populated area (**Figure 3**).<sup>65</sup> Exceeding the EPA AEG1 for the duration of 1 hour can result in discomfort and irritation, which although reversible and nondisabling, are nonetheless, undesirable health effects.<sup>66</sup> Dr. Lowry also determined that a 46.2-pounds-per-hour release of H<sub>2</sub>S from the south bay door could result in a concentration of 0.12 ppm, which exceeds the Agency for Toxic Substances and Disease Registry (ATSDR) acute minimum risk level (MRL) for short-term exposures of 0.07 ppm up to 2.42 miles from the facility (**Figure 1**).<sup>67</sup> An acute MRL is an estimate of the daily exposure to a hazardous substance that is likely to be without appreciable risk of adverse health effects from 1 to 14 days of exposure. Therefore, exceeding an MRL could result in adverse health effects.

Prior to the deaths of Jacob and Natalee Dean, the Texas Railroad Commission received several complaints from the public regarding odors, leaks, and spills associated with Aghorn-operated leases, from records analyzed by Jim Kirksey.<sup>68</sup> Mr. Kirksey noted several documented instances when the characteristic “rotten egg” smell of H<sub>2</sub>S was noticeable off-site. Individuals who reside or work adjacent to the site described being able to smell H<sub>2</sub>S routinely. [REDACTED], who have lived on property adjacent to the Facility (to the northwest) for 20 years, said they routinely smelled H<sub>2</sub>S, even in their house. [REDACTED] would get migraine headaches from the odor, and the odor was most noticeable in the mornings.<sup>69</sup> [REDACTED] recalled an H<sub>2</sub>S

<sup>64</sup> AGH OPER0005005 Inge IAR 4-13-20.

<sup>65</sup> AGH-OPER-0049348 NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>66</sup> About Acute Exposure Guideline Levels <https://www.epa.gov/aegl/about-acute-exposure-guideline-levels-aegls>

<sup>67</sup> NEICRP1899X01 Lowry Expert Report, Produced Water Hydrogen Sulfide Hazard.

<sup>68</sup> AGH OPER 0015857 Jim Kirksey Preliminary Report 8-18-20.

<sup>69</sup> AGH OPER 0017908 [REDACTED] 12-8-20.



leak near their home in 2019 and an incident 5-6 years ago when produced water was retained in their driveway. [REDACTED], who live immediately west of the Facility, have smelled H<sub>2</sub>S especially when the wind is either not blowing or when the winds come from the direction of the Facility.<sup>70</sup> [REDACTED] own a business immediately adjacent to the northwest corner of the Facility and also routinely smelled H<sub>2</sub>S, primarily in the mornings.<sup>71</sup> They also had a produced-water leak on their property from an Aghorn-owned well. Even with their proximity to the Facility and the potential for exposure, the [REDACTED], [REDACTED], and [REDACTED] were not notified about the H<sub>2</sub>S release that resulted in the deaths of Jacob and Natalee. [REDACTED], a resident who lives directly south of the Facility, indicated that he smelled H<sub>2</sub>S “all the time” before the October 2019 incident and reported an oil spill and oil in his water on December 30, 2015.<sup>72</sup> [REDACTED] recalled that [REDACTED], owner of a feed store near the Gist Et El lease, called on a regular basis to complain about strong H<sub>2</sub>S odors.<sup>73</sup> A leak in a flow line was found during an inspection resulting from a complaint from [REDACTED] on December 18, 2009. Additionally, the Texas Railroad Commission inspected the J.E. Bagley lease at Foster Field operated by Aghorn on August 30, 2019, and detected H<sub>2</sub>S gas from a tank gauge, noting that gas venting was in close proximity to the public. The Texas Railroad Commission ordered Aghorn to install safety devices or procedures to prevent escape of H<sub>2</sub>S.<sup>74</sup> Shortly after the double fatality incident involving Jacob and Natalee Dean, the Odessa Fire Department responded to an incident on November 1, 2019, at the Johnson well owned by Aghorn Operations.<sup>75</sup> Hydrogen sulfide levels were “over limit” on the monitors, and two neighboring homes located 100-200 yards away from the well were evacuated. These incidents indicate that the release of H<sub>2</sub>S from Aghorn facilities was a chronic issue, and the potential to exceed health-based standards existed.

Repeated or prolonged exposure to H<sub>2</sub>S has been associated with low blood pressure, headache, nausea, loss of appetite, weight loss, eye-membrane inflammation, and chronic cough.<sup>76</sup> Chronic exposure to H<sub>2</sub>S can result in persistent and permanent neurological symptoms, including psychological disturbances. Reported effects from low levels of exposure include incoordination, poor memory, hallucinations, personality changes, and loss of sense of

<sup>70</sup> AGH OPER 0017910 [REDACTED].

<sup>71</sup> AGH OPER 0017905 [REDACTED] 12-8-20 IAR Interview.

<sup>72</sup> AGH OPER 0016382 [REDACTED] 8-18-20 Interview IAR.

<sup>73</sup> AGH OPER 0015924 [REDACTED] 8-11-20 IAR 3<sup>rd</sup> Interview.

<sup>74</sup> AGH OPER 0011451 9-24-19 NOI 8-30-19 Inspection Bagley JE-Fouts.

<sup>75</sup> AGH OPER 0090758 Interview of [REDACTED] 5-20-20 IAR.

<sup>76</sup> Legator MS, Singleton CR, Morris DL, Philips DL. Health effects from chronic low-level exposure to hydrogen sulfide. Arch Environ Health. 2001 Mar-Apr;56(2):123-31.



smell. Increases in the occurrence of neurological symptoms such as headaches, loss of balance, memory loss, and fatigue have been reported in studies of communities living near industrial sources of hydrogen sulfide. For example, neurological effects were found in a 20-month-old child who was exposed to low levels of  $H_2S$  for a year from  $H_2S$  emitted from a coal mine.<sup>77</sup> Chronic, low-level exposure to  $H_2S$  can also result in respiratory effects. Studies of communities near sources of elevated hydrogen sulfide have found increases in respiratory symptoms such as nasal irritation, shortness of breath, cough, exacerbation of asthma, and increases in visits to the emergency room. Therefore, residents could be at risk from adverse health effects from repeated, low-level exposure to  $H_2S$  from Aghorn Operations facilities given the high levels of  $H_2S$  in produced water and the propensity for leaks and spills.

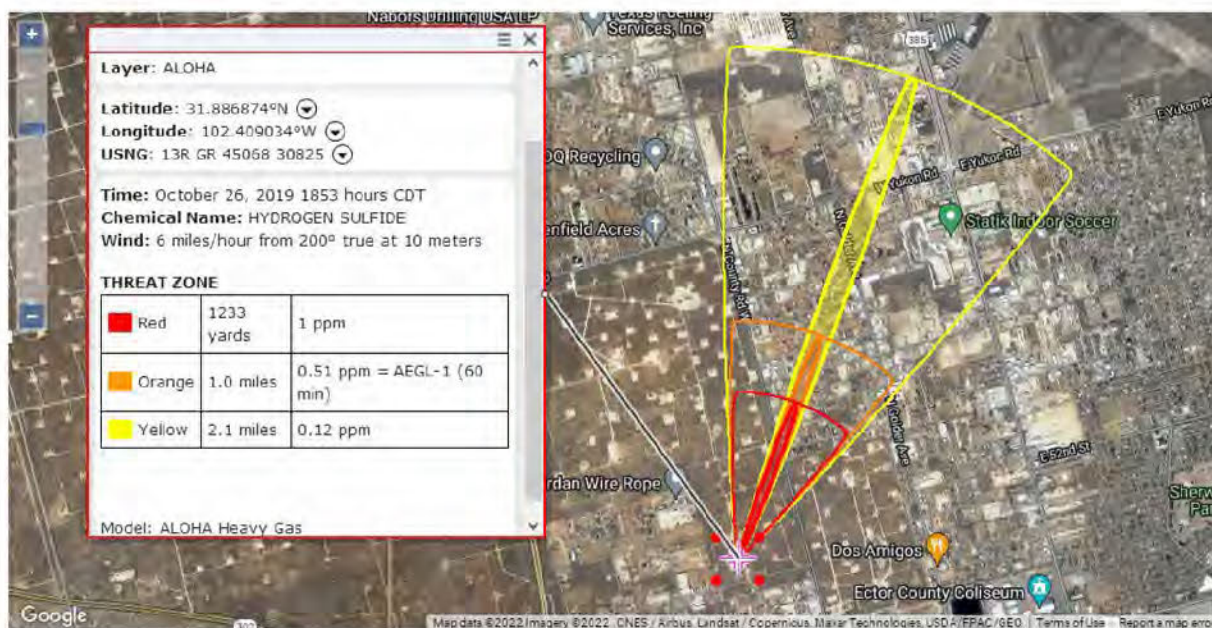


Figure 3. “MARPLOT® of ALOHA® threat zones of 0.12 ppm, 0.51 ppm, and 1 ppm for a ground level hydrogen sulfide release of 46.2 pounds per hour from the south bay door of the facility with the wind from the southwest (200 degree) at 6 miles per hour at 10 meters” from the Lowry Expert Report. The ATSDR acute MRL (0.07 ppm) was exceeded at least 2.1 miles from the facility. The EPA 1-hour AEGL was exceeded up to a mile from the facility from the facility. The ACGIH TLV was exceeded 1233 yards from the facility.

## CONCLUSION

In conclusion, the release of  $H_2S$  by Aghorn Operations and the lack of warning systems, training, and personal protective equipment resulted in the deaths of Jacob and Natalee Dean and put responders at risk. Additionally, the repeated releases without proper monitoring and

<sup>77</sup> ATSDR 2016 Toxicological Profile for Hydrogen Sulfide.

personal protective equipment put employees at risk for adverse health effects and potential death. Nearby residents may also be at risk especially from repeated, low-level exposures given the propensity for releases of H<sub>2</sub>S from the Facility.

## APPENDIX A: CURRICULUM VITAE

KRISTEN A. KETELES, Ph.D.

### Work Address

EPA National Enforcement Investigations Center  
Denver Federal Center  
PO Box 25227, Bldg 25, Rm 2A-215  
Denver, CO 80225  
303-462-9313  
Keteles.Kristen@epa.gov

### Education

Louisiana State University	2001	Ph.D. Biological Sciences, Zoology
Coastal Carolina University	1995	B.S. Marine Science

### Field of Specialization and Areas of Interest

- Human Health and Ecological Risk Assessment
- Toxicogenomics (gene expression in response to chemicals)
- Environmental Forensics/Hazard Assessment
- Children's Environmental Health
- Pesticides
- Fate and Effects of Contaminants of Emerging Concern in the Environment

### Professional Society Affiliation

Society of Toxicology  
Society of Environmental Toxicology and Chemistry

### Professional Experience

*Senior Toxicologist, EPA National Enforcement Investigations Center (NEIC), 2016-Present*

**Duties:** Provides technical assistance in the field of toxicology to support criminal investigations and prosecutions, including written reports and declarations, and expert witness testimony during trials and sentencings involving intentional poisonings and chemical exposures resulting from criminal negligence. Communicates potential risks from chemical exposure to juries and other lay audiences. Serves on national technical workgroups including the Risk Assessment Forum and the Science Support Panel. Reviews science policy documents and briefs the NEIC director on these documents. Remains active in the field of toxicology by planning and conducting research. Directs data collection and analysis related to risk assessment as well as advanced monitoring research and other studies. Determines risk from chemical exposures to law enforcement and first responders and establishes clearance levels. Serves as chair of the EPA Risk Assessment Forum Human Health Oversight Committee.

*Toxicologist, Detailed to Office of Land and Emergency Management (OLEM), Policy Analysis and Regulatory Management Staff (PARMS), May-September 2022.*

**Duties:** Served as a national and international science policy expert specializing in areas of environmental risk and toxicological assessment, provides science policy advice and support to OLEM senior leadership on environmental contaminants. Coordinated the development, evaluation, and review of science policy guidance and regulatory actions. Responsible for analyzing complex environmental contamination problems, identifying science policy issues, and communicating key information to senior leadership. Reviewed toxicology studies for technical merit and regulatory documents for policy implications. Served as an expert in hazard identification, dose-response analysis, and exposure pathway analysis for a wide range of contaminants, including metals, fibers, solvents, and persistent bioaccumulative substances. Provided advice and guidance on the potential impacts of scientific findings, risk assessments, or regulatory analyses.

*Toxicologist (National Technical Expert), EPA Region 8, Technical Assistance Unit and Pollution Prevention, Pesticides, and Toxics Unit, Denver CO, 2008-2016*

**Duties:** Provided technical assistance regarding human health and ecological effects from exposure to pesticides, metals (including mercury), volatile organic compounds and other toxics to the public, state and local officials, and other federal agencies. Served as a technical expert on risks and effects of pesticides and toxics (PAHs, VOCs, PCBs, lead, mercury, asbestos). Conducted human health and ecological risk assessments at superfund sites. Assessed risk from exposure to chemicals from spills and releases during Emergency Response operations and established screening levels and clearance levels. Served as technical expert on workgroups to develop guidance and policies to protect human health and the environment from exposure to chemicals. Assisted with the training of pesticide applicators. Provided toxicological expertise to the Children's Environmental Health and Air Toxics Program. Served on the Air Toxics Risk Assessors workgroup and the Chemical Safety for Sustainability Implementation Team. Prepared briefings on technical issues for senior leadership. Conducted research on the effects of endocrine disrupting chemicals on aquatic life using toxicogenomic tools. Presented information at scientific and public meetings. Provided technical assistance in the field of toxicology to support criminal investigations and prosecutions.

*Acting Deputy Director, EPA National Enforcement Investigations Center (NEIC), 2011*

**Duties:** Provided management oversight and technical leadership to NEIC's program managers and branch chiefs to ensure that the overall goals to provide forensic science support to the enforcement community of EPA were achieved. Resolved differences in scientific opinion and developed a framework to address these differences.

*Affiliate Faculty, Colorado Christian University, Lakewood CO, 2007-Present*

**Duties:** Teaches Biology (general education), Environmental Science, and Human Genetics and Genomics.

*Instructor, Miami University, Oxford OH, 2015-Present*

**Duties:** Teaches online classes in the field of environmental science and conservation including, Biology in the Age of Technology, Primate Biology and Conservation, Great Lakes Ecosystem, and Environmental Stewardship Education.

*Lecturer, University of Colorado Denver, Denver, CO, 2009-2011*

**Duties:** Taught graduate course in Environmental Biology.

*Coastal Watershed Condition Assessment Coordinator (Contaminants Specialist), National Park Service-Water Resources Division, Contractor with Texas A&M University, 2004-2008*

**Duties:** Assessed threats to public health and natural resources within and adjacent to coastal National Parks; provided technical assistance regarding health effects and natural resource damage during chemical spill response; and provided technical expertise for spill contingency planning in coastal National Parks. Coordinated projects working with multiple stakeholders to assess environmental impacts to National Park resources. Ensured that projects were completed on time and met the scope of work. Communicated the results of the assessments to Park managers.

*Assistant Professor of Biology, University of Central Arkansas, Conway, AR, 2001-2004*

**Duties:** Advised graduate students, maintained a research program in environmental toxicology, taught graduate and undergraduate courses (Environmental Toxicology, Health Effects from Environmental Contaminants, Environmental Science, and Introductory Biology).

*Visiting Scientist, Federal Bureau of Investigation, Counter Terrorism Forensic Science Research Unit (FBI-CTFSRU) Quantico, VA, 2003.*

**Duties:** Developed a Polymerase Chain Reaction (PCR) DNA-based method to detect biothreats (*Bacillus anthracis*) in environmental samples.

*Adjunct Professor of Biology, River Parishes Community College, Sorrento, LA, 2001*

*Graduate Research Assistant, Louisiana State University, Baton Rouge, LA, 1999.* Effects of PAH on trace metal bioaccumulation in the darter goby, *Gobionellus boleosoma*. Planned and conducted research.

*Graduate Research Assistant, Louisiana State University Baton Rouge, LA, 1998.* Hazardous Materials Research Center: Fate of PAH contaminants in the environment.

*Senior Research Associate, Dartmouth College, Hanover, NH, 1996-1997.* Superfund Basic Research Program: Bioaccumulation and biomagnification of toxic metals including mercury in lake foodwebs throughout the Northeastern Region of the U.S.A. Planned research activities, collected data, and briefed leadership including a congressional delegation on the findings of the research.



## **Workgroups Served On**

National Toxicology Program Workgroup  
Chemical Safety for Sustainability Implementation Team  
Risk Assessment Forum Human Health Oversight Committee, Chair 2020  
Science Technology Policy Council Science Support Panel  
Air Toxics Risk Assessors  
OLEM Human Health Regional Risk Assessors Forum

## **Presentations**

Keteles, K.A. and A. R. Kadry. A Risk-Based Investigation on an Accidental Exposure of a Bison Herd to Chlorophacinone. Society of Toxicology, San Antonio, Texas, March 2018.

Keteles, K.A. Toxicology and Environmental Crimes: Answering, “So what?” Colorado Environmental Crimes Task Force, February 23, 2017.

K.A. Keteles, A.M. Vajda, D. Winkelman, J. Beihoffer, D. Ekman, D.L. Villeneuve, J.M. Lazorchak, A. Jastrow, T. Collette. Use of bioactivity tools to measure estrogenic mixtures below WWTPs with differing treatment technologies. Society of Environmental Toxicology and Chemistry 36<sup>th</sup> Annual Meeting, Salt Lake City, UT, November 2015.

Dewoskin, R.S., G.L. Diamond, J. Brown, M.H. Follansbee, K.A. Keteles, C.R. Partridge. Predicting Blood Lead Following Short-Term Exposures Using the All Ages Lead Model (AALM), Society of Toxicology, Phoenix, AZ, March 2014.

Keteles, K.A. Schwindt, A.R., Winkelman, D.L., Vajda, A.M., Beihoffer, J. Bioindicators of exposure to Endocrine Active Chemicals, Rocky Mountain Society of Environmental Toxicology and Chemistry Denver, CO, April 2013.

Keteles, K.A. Science for EPA Region 8’s Future (invited), National Academy of Sciences National Research Council Committee, Washington, DC, August 8, 2011.

Keteles, K.A. Children’s special vulnerabilities to environmental exposures including prenatal and developmental windows of susceptibility, Improving Children’s health through federal collaboration speaker series, November 10, 2010.

Keteles, K.A. EPA’s response to the Deepwater Horizon Oil Spill, (Invited) America Water Resources Association, Denver CO, August 2010.

Keteles, K.A. Rethinking pristine: Contaminants of emerging concern in high elevation Lakes, Water Professionals Meeting, Fort Collins, CO, Feb 2010.

Keteles, K.A. Why children are not little adults: toxicology 101. Children’s Environmental Health Summit, Missoula MT, August 11, 2009.

Keteles, K.A., E. Smith, T. Walter, and D.S. Johnson. Variation in cadmium bioavailability, Society of Environmental Toxicology and Chemistry 25<sup>th</sup> Annual Meeting, Portland, Oregon, November 2004.

Keteles, K.A., T. Walter, E. Smith, M. Schroeder. Invited Paper. The influence of water quality on trace metal bioavailability. Arkansas Water Resources Meeting, Fayetteville, AR, April 2004.

Keteles, K.A. The influence of nutrients on the toxicity of arsenate and arsenite. Society of Environmental Toxicology and Chemistry 24<sup>th</sup> Annual Meeting, Austin, Texas, November 2003.

Keteles, K.A. and J.W. Fleeger, The trophic transfer of exoskeleton-associated metals in crustacean prey (*Palaemonetes pugio*) to a fish predator (*Fundulus grandis*). Society of Environmental Toxicology and Chemistry 22<sup>nd</sup> Annual Meeting, Baltimore, MD, November 2001.

Keteles, K.A. and J.W. Fleeger. The effect of source of exposure on the uptake and partitioning of metals by *Palaemonetes pugio*. Society of Environmental Toxicology and Chemistry 21<sup>st</sup> Annual Meeting. Nashville, TN, November 2000.

Keteles, K.A. and J.W. Fleeger. Uptake and partitioning of metals by *Palaemonetes pugio*. Society of Environmental Toxicology and Chemistry 20<sup>th</sup> Annual Meeting, Philadelphia PA, November 1999.

## Publications

Cavallin, J.E., W.A. Battaglin, J. Beihoffer, B.R. Blackwell, P.M. Bradley, A.R. Cole, D.R. Ekman, R.N. Hofer, J. Kinsey, K. Keteles, R. Weissinger, D.L. Winkelman, and D.L. Villeneuve. Effects-Based Monitoring of Bioactive Chemicals Discharged to the Colorado River before and after a Municipal Wastewater Treatment Plant Replacement. *Environmental Science & Technology* 2021 55 (2), 974-984.

Weissinger, R.H., B.R. Blackwell, K.A. Keteles, W.A Battaglin, P.M. Bradley. (2018) Bioactive contaminants of emerging concern in National Park waters of the northern Colorado Plateau, USA. *Science of The Total Environment*. 636: 910–918

Ekman, D.R., K.A. Keteles, J. Beihoffer, J.E. Cavallin, K. Dahlin, J.M. Davis, A. Jastrow, J.M. Lazorchak, M. Mills, M. Murphy, D. Nguyen, A.M. Vajda, D.L. Villeneuve, D.L. Winkelman, and T.W. Collette. (2018) Use of Targeted and Untargeted Effects-based Monitoring Tools to Assess Impacts of Wastewater Effluents on Fish in the South Platte River, CO. *Environmental Pollution* 239: 706–713.

Bai, X, Lutz, A., Carroll, R. Keteles, K., Dahlin, K., Murphy, M., and Nguyen, D. (2018) Evaluating occurrence, distribution, and seasonality of pharmaceuticals and other emerging contaminants in urban watersheds. *Chemosphere*. 200: 133-142.

Jastrow, A., D. Gordon, K. Auger, E. Punska, K. Arcaro, K. Keteles, D. Winkelman, D. Lattier, A. Biales, J. Lazorchak. (2017) Tools to minimize inter-laboratory variability in vitellogenin gene expression monitoring programs. *Environmental Toxicology and Chemistry*. 36 (11), 3102-3107.

Schwindt, A.R., D. Winkelman, K.A. Keteles, M. Murphy, A. Vajda. (2014) An environmental estrogen disrupts fish population dynamics through direct and transgenerational effects on survival and fecundity. *Journal of Applied Ecology*. 51(3), 582-591.

U.S. EPA (Environmental Protection Agency). (Contributing Author) (2010) Integrating Ecological Assessment and Decision-Making at EPA: A Path Forward. Results of a Colloquium in Response to Science Advisory Board and National Research Council Recommendations. Risk Assessment Forum. Washington, DC. EPA/100/R-10/004.

Millward, R.N., Fleeger, J.W., Reible, D.D., Keteles, K.A., Cunningham, B.P. and Zhang, Li. (2001) Pyrene bioaccumulation, effects of pyrene exposure on particle size selection and fecal pyrene content in the oligochaete, *Limnodrilus hoffmeisteri* (Tubificidae, Oligochaeta). *Environmental Toxicology and Chemistry*. 20 (6), 1359–1366.

Keteles, K.A. (2001) Metal partitioning in *Palaemonetes pugio* and its role in depuration and trophic transfer. Dissertation, Louisiana State University, Baton Rouge, LA.

Keteles, K.A. and J.W. Fleeger (2001) Metal partitioning among tissues and exoskeleton of *Palaemonetes pugio* and its role in depuration and trophic transfer. *Marine Pollution Bulletin*. 42: 1397-1402.

### **Awards, Grants, and Fellowships**

Gold Medal for Commendable Service (2018), Terminix Enforcement Criminal Team for Outstanding Support to the Terminix Criminal Enforcement Case.

EPA Science Achievement Award (2018), South Platte Endocrine Disruption Study Team, for engagement in a multi-year collaborative research project to advance scientific knowledge and analytic methods regarding the presence of estrogenic chemicals in public water ways.

Bronze Medal for Commendable Service (2017), Boasso America Criminal Case Team in recognition of the Boasso Enforcement Team's outstanding investigative efforts leading to the sentencing of Boasso and nine individual defendants totaling 343 months of incarceration.

Regional Applied Research Effort: "Using a biosensor tool to evaluate the safety of produced water for beneficial reuse during drought conditions in the west," 2017, \$98,440.

EPA Regional Applied Research Effort: "Application of 21<sup>st</sup> century bioanalytical tools to identify sources and effects of bioactive contaminants associated with select municipal wastewater discharges to the South Platte and Colorado River watersheds," 2017, \$134,000.

EPA Region 8 Office of Enforcement Compliance and Environmental Justice Certificate of Excellence (2016) for exemplary work to quickly resolve a significant pesticide misuse by securing a fast and effective remedy in the Meyers Ranch incident.

Science Achievement Award (2013) for outstanding achievement in cementing partnerships to bridge a critical gap in laboratory capacity with the development of a novel laboratory method for the expedited assessment of the viability of *Bacillus anthracis* from an environmental sample.

EPA Science Award (2012) for initiative and creativity in the use of novel molecular biology methods to detect endocrine active chemicals in the environment.

EPA Bronze Medal for Commendable Service (2011), Chemical Safety for Sustainability Research Program Development Team for design and development of the Chemical Safety for Sustainability Research Program Action plan, which embodies innovative, trans-disciplinary approaches for understanding chemicals and enhancing sustainability.

Regional Methods Initiative: "Development of a Whole Effluent Test for androgenicity and estrogenicity," 2009, \$180,000.

Office of Research and Development Pharmaceuticals in the Environment Workshop 2009, \$60,000.

Oak Ridge Institute for Science and Education Fellowship: Visiting Scientist Fellow at the Federal Bureau of Investigation Academy.

URC Faculty Research Grant: "Variation in the uptake of potentially toxic trace metals by aquatic organisms inhabiting agricultural vs. forested watersheds" 2002, \$8,795.00.

University Research Council Summer Stipend: "The Effect of Calcium Limitation on Cadmium Uptake," 2002, \$2,600.

NSF UFE Workshop, "New Approaches and Techniques for Teaching Science: Addressing Environmental Problems to Stimulate Undergraduate Learning."

"The influence of source of exposure on the uptake and partitioning of metals by *Palaemonetes pugio*" National Sigma Xi Grant-in Aid of Research; 1999, \$800.

### **Litigation Experience: Trials and Depositions**

*USA v. Wasatch Railroad Contractors and John E. Rimmasch*, District of Wyoming, Cheyenne, WY; April 11, 2022; testified as an expert witness on harm from exposure to asbestos.

*USA v. Dennis Morgan*, Middle District of Pennsylvania, Williamsport, PA; March 31, 2022; testified as an expert witness at the sentencing on harm from lead exposure in children.

*USA v. Yoo Jin Management Company, Ltd* District of Alaska, Anchorage, Alaska; March 15, 2021; testified as an expert witness in a restitution hearing regarding harm from exposure to asbestos.

*USA v. CMS Energy Corporation*; Western District of Michigan, Grand Rapids, MI; February 22, 2018; deposition at US Department of Justice Environment and Natural Resources Division. Washington, DC.

*USA v Raymond Mitchell*; Southern District of Georgia, Savannah, GA; March 18, 2016; testified as an expert witness at the sentencing on the toxicity and potential for harm from exposure to naphthalene.

*USA v Ryan Chamberlain*; Northern District of CA, San Francisco, CA; February 5, 2016; testified as an expert witness in a Delbert hearing on the use of toxicity data to determine the lethal effects from exposure to the biological toxins, ricin and abrin.

*USA v Carl Kieser*; Central District of Illinois, Peoria, IL; October 29, 2014; testified as an expert witness in a criminal trial on the toxicity of the herbicide, diuron to aquatic life.

*USA v Martin Kuna*; District of Oregon, Portland; OR, July 22, 2013; testified as expert witness at the sentencing on the effects of lead on children.

*Colorado v. Joseph Loskinski*; Weld County District Court, Greeley, CO; December 12, 2012; testified as an expert witness at the sentencing on the effects and lethality of the rodenticide, strychnine.

### **Litigation Experience: Expert Reports, Declarations and Affidavits**

Expert witness opinion report for *USA v. Edward Miller*; District of Nebraska; April 8, 2020; expert opinion report on health effects from exposure to chemicals found at illegal dump sites in Hamilton County, Nebraska.

Expert witness opinion report for *USA v. Lloyd Robl*; Western District of Wisconsin, Madison, WI; July 30, 2019; expert opinion report on health effects from exposure to asbestos.



Expert witness opinion report for *USA v. Total Reclaim Lorch and Zirkle*; Western District of Washington, Seattle WA; March 25, 2019; expert opinion report on health risks from exposure to mercury from electronic waste.

Declaration for *USA v. Tonawanda Coke Corporation*; Western District of New York, Buffalo, NY; September 17, 2018; expert opinion on the health effects from exposure to benzene and particulate matter.

Expert witness opinion report for *USA v. Chelsea Environmental-Paul Potter*; Eastern District of VA, Alexandria, VA; August 21, 2018; expert opinion report on health effects from exposure to asbestos.

Expert witness opinion report for *USA v. CMS Energy Corporation*; Western District of Michigan, Grand Rapids, MI; January 16, 2018; expert opinion report on risks from the discharge of cement kiln dust leachate.

Expert witness opinion report for *USA v. OE Construction Corporation*; District of Colorado, Denver, CO; June 19, 2017; expert opinion on health effects from exposure to diesel emissions.

Expert witness report for *USA v. Dipen Patel*; Northern District of Indiana, Hammond, IN; January 26, 2017; expert opinion on health effects from exposure to the pesticide, Doom (active ingredient, dichlorvos).

Declaration for *USA v. Ryan Chamberlain*; Northern District of California, San Francisco, CA; February 5, 2016; declaration to support the government's opposition to the defendant's motion to exclude expert witness testimony on the use of toxicological data to determine the toxicity of abrin and ricin.

Expert witness report for *USA v. Terminix International Company*; District Court of the Virgin Islands, St. Thomas, VI; December 1, 2015; expert opinion on the methylbromide exposure incident.

Expert witness report for *USA v. Cenex Harvest States, Inc*; District of Montana, Great Falls, MT; January 22, 2013; expert opinion on the toxicity of the gases released from a warehouse fire to livestock and human health.

Expert witness report for *USA v. Martin Kimber*; Northern District of New York, Albany, NY; February 2012; summary of the health hazards of mercury by inhalation exposure.

Expert witness report for *USA v. Seville Colony*; District of Montana, Great Falls, MT; January 17, 2012; expert opinion on the imminent and substantial endangerment from the illegal application of the rodenticide, strychnine.

Expert witness report for *USA v. Bazan et.al.*; United States District Court District of Kansas, Kansas City, KS; March 14, 2011; expert opinion on the toxicity of the pesticide, methomyl.

Expert witness report for *USA v. Martha Hebert*; Eastern District of Louisiana, New Orleans, LA; November 10, 2011; expert opinion on the falsification of whole effluent toxicity data.

Expert witness report for the *USA v. Roy Stricklin*; District of Wyoming, Casper, WY; September 8, 2011; expert opinion on the risks to a population from the exceedance of the drinking water maximum contaminant level for coliform.

AFFIRMATION

I have reviewed my Professional Resume and declare and affirm that the information provided therein is true and correct to the best of my knowledge.

KRISTEN  
KETELES

Digitally signed by  
KRISTEN KETELES  
Date: 2022.10.18 07:53:23  
-06'00'

Kristen Keteles, Ph.D.  
Toxicologist